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THE NEURO-EMBRYOLOGIC STUDY OF BEHAVIOR: PRINCIPLES, PERSPECTIVE AND AIM[1]

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EMBRYOLOGY as a scientific method arose in the domain of morphology. Although there were early physiological and chemical observations upon the embryo, these were relatively casual. It was in the interest of explaining the structure of the animal body that embryology acquired a technique of its own and attained to the dignity of a biological science. Embryology as a growing science, however, is now through and through physiological. Witness, for example, the experimental schools of Spemann, of Harrison, of Child, and the tomes of Needham on "Chemical Embryology." Embryology has in fact gone afield to explore every nook and cranny, every crook and turn of the developing organism experimentally, physiologically, chemically; and even the problem of animal behavior is now being attacked by numerous investigators with the method of this originally morphological science. It is this latter field of investigation that engages our attention at this time.

The behavior of embryos is not of exclusively recent interest. Movements of snails within the egg were studied by Swammerdam; mussels and oysters, by Leeuwenhoek (1695). Even earlier than this (1651) William Harvey gave an account of movements of the chick during the early days of incubation. After Harvey, however, a century elapsed before the next important contribution was made on the movements of the chick embryo. This was by Beguelin (1757), to whom is accredited the notable accomplishment of keeping the embryo alive in the opened egg for fifteen days. In the earlier part of the nineteenth century, von Baer (1828) experimented upon the sensitivity and contractility of the fetal membranes of the chick, although it remained for Vulpian (1857) to establish the distinction between

[1] Address of the president of the American Association of Anatomists, Cincinnati, April 13, 1933.

the active movements of the embryo itself and the passive movements caused by contractions of the amnion. Finally, this period of more than two centuries of fluctuating or intermittent interest in the behavior of the embryo culminated in the epochal work of Preyer (1885) on the movements of embryos, the results of which are incorporated in his "Specielle Physiologie des Embryo."

During this period a notable beginning was made in neuro-embryologic study of behavior, particularly by Remak, Lereboullet and Nussbaum. Remak (1854) discovered that muscle cells without nerves cause the contraction of the amnion; Lereboullet (1861) sought the explanation for the earliest movements of the trout, and concluded that they occurred before muscle fibers and motor nerves were developed, in this possibly anticipating Wintrebert, or he may have seen those movements in the blastoderm which have recently been described by Yamamoto; and Nussbaum (1883), on the basis of the behavior of the embryo of the trout after transections at various levels, discovered that the sensory and motor nerves are functional before they acquire the myelin sheath.

More recent investigations may be mentioned only in the briefest possible manner. Among those who, since Preyer, have studied the behavior of embryos without specific reference to neurology are: for invertebrates, Pearl on Limulus; for fishes, Tracy and Yamamoto; for birds, E. L. and E. R. Clark, and Kuo on the chick; for lower mammals, Swenson on the rat, Pankratz on the rabbit, Graham Brown, and Carnios on the cat; on the human fetus, Strassmann, Krabbe, Yanase, Bolaffio and Artom, and Minkowski. Among those who have undertaken to correlate anatomy with embryonic behavior are: Prosser on the earthworm; Wintrebert, Paton and Davenport Hooker on fishes and amphibians; Tuge on the turtle; Lane, Blincoe, East, Pankratz, Angulo and Windle and Griffin on lower mammals, and Davenport Hooker and Hogg on man. Minkowski, also, has made extensive neurological studies in reference to his unparalleled observations on the behavior of the human fetus; but it is not clear that these studies were made on the same individuals that were observed in action. Flechsig's work on myelinization might also be thought of in this connection; but here again the reference to behavior-capabilities may be made only in a general way. On the other hand, the current neurological studies of the development of behavior are based on anatomical material that has been tested for its behavioral capability under conditions that are as nearly as possible normal. Studied in this manner on the basis of physiologically tested material, neurology and behavior are reciprocally highly illuminating.

The neuro-embryologic study of behavior has proved to be not unlike hunting big game in a strange country: one finds many tracks of the game here and there before one comes upon the path which leads to its rendezvous. But, in this discussion, we shall pass by the promiscuous details of the field and take up some of the trails which are sufficiently defined to warrant our following them, tentatively at least, as guiding principles.

The principles which I have in mind for discussion on this occasion are statements of fact concerning the development of the nervous system of Amblystoma; they can be regarded as tentative only in their general application to vertebrates. On the neurological side of the problem they are, first, the primacy of a motor mechanism of total integration; second, the development of mechanisms of partial integration through localized acceleration of growth; and third, progressive organization of the nervous system from the whole to the part

There is in Amblystoma a motor mechanism which integrates all somatic movements into a unitary pattern of action. It is a longitudinal conducting system lying next to the floor plate on either side. After the development of Mauthner's fiber it occupies the space in the spinal cord between this fiber and the floor plate, and consists of caudally conducting neurons which provide the earliest motor innervation to the axial and appendicular muscles. In the rhombencephalon and mesencephalon this primary motor path clearly becomes the fasciculus longitudinalis medialis in its early stage of development We are justified, therefore, in the view that, in urodeles, the fasciculus longitudinalis medialis, beginning in the mesencephalon and extending the whole length of the rhombencephalon and spinal cord, is a mechanism of total integration.

In the higher vertebrates the fasciculus longitudinalis medialis is the first longitudinal conducting system to make its appearance. According to His, it is present in the human embryo of 6.9 mm. In point of time, therefore, it is the primary motor mechanism in the human brain. But as a discrete structure it does not extend the entire length of the spinal cord of the mammal as it does in the urodele, but it becomes confluent with the fasciculus proprius ventralis in the upper part of the spinal cord. This condition is correlated with the fact that in the mammal the axial muscles are not directly locomotor, but serve locomotion indirectly through posture, while the postural reactions are taken over largely by such tracts as the fasciculus proprius, vestibulo-spinal and rubo-spinal. Conjugate deflection of the eyes, on the other hand, although integrated with posture, is an independently moving somatic system primarily re-

lated to locomotion. Accordingly, in mammals the eye-muscles maintain their primitive relation with the mechanism of total integration.

But in higher vertebrates the fasciculus longitudinalis medialis does not constitute all this mechanism of total integration. For example, according to recent work by C. Judson Herrick, the interpeduncular nucleus is an important part of this system, even in Necturus. The importance of this nucleus arises from the fact that its efferent neurons form a component of the mechanism of total integration, while it is an end-station for the habenulo-peduncular, the mamillo-peduncular and the olfacto-peduncular tracts and the nervus terminalis. Through these conduction paths the mechanism of total integration is brought under the direct influence of the olfactory field at an exceedingly early period. These tracts, in fact, express the earliest physiological activities of the fore-brain. In Amblystoma the nervus terminalis is the first tract to become clearly differentiated in the forebrain. In man, according to His, the fasciculus mamillo-tegmentalis is present in the embryo of 10.9 mm, and the habenulo-peduncularis in the embryo of 15.5 mm. Accordingly, these tracts are laid down a relatively long time before the embryo at 20 mm in length begins to move. It is obvious, therefore, that the earliest influence of the forebrain on behavior acts, not through local reflex mechanisms, but through the mechanism of total integration.

Moreover, while comparative anatomy supports the validity of this principle in the evolution of the nervous system, it finds confirmation also in the field of psychology and psychopathology, for in his interpretation of posture, sleep and consciousness, Schilder[2] postulates a mechanism that conforms closely with the mechanism of total integration as here presented. But it would be an error to think of this mechanism as a fixed structure, for it is a growing organ; and in its growth it incorporates more and more of the higher portions of the nervous system, according to the position of the animal in the scale of behavior.

The second tentative principle raises the controversial point of equipotentiality. Probably there is no such thing as absolute equipotentiality in living organisms, for the functions of an individual cell would seem to require differentiation of parts and division of labor. But we do not know the absolute of anything; we use concepts, as we use things, when they are useful; and in this problem the concept of equipotentiality is useful because it expresses a condition which prevails in a very high degree in certain parts of the embryonic nervous system.

The motor mechanism of total integration in Amblystoma, excepting in its most rostral portion, appears to be an equipotential system when it begins to function, for all parts of it are doing the same thing—conducting impulses tailward and to the axial muscles. The same may be said of the primary sensory system, except that its cells are conducting headward from the receptors. Moreover, these primary sensory and motor cells are essentially alike in structure, for they are both neurons of central tracts, with peripheral branches functioning as nerves. Furthermore, with equipotential motor and sensory systems, the spinal cord itself, with the exception of its most rostral part, is, in the earliest functional condition, equipotential along its longitudinal axis, for every segment in this region is doing what all the others are doing, that is to say, conducting headward and tailward, and receiving sensory and sending out motor impulses of the same order.

This equipotential condition of the spinal cord in the region under consideration persists until about the time that the bud of the hind leg makes its appearance on the surface of the body. At this time proliferation of cells in the spinal cord undergoes acceleration according to a definite pattern which centers in the region that is destined to innervate the leg. The rate of proliferation in this center reaches its climax a considerable time before the leg begins to move as a part of the total pattern, and the highest rate is in the seventeenth segment, which is the middle one of the three which supply nerves to the leg. This localized acceleration in proliferation of cells is clearly allied with the development of the function of the leg as a whole, and expresses itself in an enormous increase in the number of cells and in the mass of gray substances in the region of the localized functions. Following this period of local acceleration of cell-division, the differentiation of white substance begins to accelerate in the same localized center, and this acceleration is also clearly correlated with the beginning of the localized function of the leg.

The spinal cord, owing to its relatively symmetrical organization along an approximately straight longitudinal axis, is especially favorable for studies of this kind, but the operation of the principle of localized acceleration of growth has been demonstrated in Amblystoma in the origin of localized functional centers of the medulla oblongata, the cerebellum, the mesencephalon, the diencephalon and the cerebral hemispheres. Furthermore, the description of the embryonic development of the three-layer and four-layer structure of the endbrain of the cat by Tilney and Kubie,[3] Langworthy's[4] description of the

[2] Paul Schilder, "Brain and Personality." New York and Washington, 1931.

[3] Frederick Tilney and Lawrence S. Kubie, *Bulletin of the Neurological Institute of New York*, Vol. 1, No. 2, pp. 229–313.

[4] O. R. Langworthy, Contribution to Embryology, No.

development of the cruciate gyrus in relation to its function in the kitten, and the early differentiation of the cerebral cortex of the human fetus as described by Bolton and Moyes,[5] give positive evidence that the localization of function in the cerebral cortex of mammals and man comes about according to the same principle that operates in establishing the simplest localized function in the spinal cord of Amblystoma—namely, not by accretion of independently functional mechanisms, but by localized acceleration of growth within a relatively equipotential functioning system.

In addition to the evidence drawn from embryology for this mode of ontogenetic development of localized or partial mechanisms of integration, there is conclusive evidence in comparative anatomy that the evolution of the nervous system has followed the same principle. This is shown particularly in extensive unpublished work by C. Judson Herrick on the forebrain of Amphibia. In the course of evolution, unitary centers of low degree of differentiation and relatively homogeneous in function have become differentiated into separate centers with different functional relation.

The principle of progressive organization from the whole to the part may be illustrated by the development of spinal ganglia in Amblystoma. Eleven pairs of these ganglia in ten successive stages of development have been studied to determine whether bilateral symmetry, in regard to numbers of cells, is attained first in the members of pairs of ganglia or in the total numbers of cells in all the ganglia on the opposite sides.

The method of treatment consisted in determining the mean number of cells in the ganglia of each pair and the departure of the individual ganglia of the pair from this mean, the total numbers of cells in all the ganglia on opposite sides of each specimen being treated in the same manner. As a result of this study, the maximum deviation from the mean is always found to be much greater for pairs of ganglia, in a given individual, than for the total numbers of cells of the two sides. This difference is greatest in the youngest specimen, and least in the oldest, with almost regular gradation between the youngest and the oldest. In the youngest specimen the maximum departure from the mean in individual pairs of ganglia is 54.8 per cent. of the mean, whereas the corresponding figure for the totals is 1.9 per cent. In the oldest specimen the departure for individual pairs of ganglia is 5 per cent.; and for the total, 0.3 per cent.

Furthermore, the segments of the spinal cord which correspond to these ganglia in the same animals were studied by the same method. The number of mitotic figures in each segment of the cord and the total numbers for the opposite sides of each individual were determined, with the result that organization within the spinal cord, as indicated by rates of mitosis, was found to proceed from larger to smaller divisions. Now, since the parts included in this study are those concerned with the innervation of a pair of limbs, we are justified in the statement that, in so far as the question has been investigated, the organization of a localized functional center of the nervous system progresses from the whole to the part. Symmetry of the whole is not acquired by the accretion of individually symmetrical parts; but the symmetry of parts is acquired by compensatory growth under the leadership of the whole.

We may now consider these neuro-embryologic principles in relation to behavior, which is their natural, physiological perspective.

The mechanism of total integration expresses itself in a total pattern of action without physiologically distinct parts. An action is regarded as total when it involves all the muscles of a functional system that are capable of responding at the time. In Amblystoma the development of the total reaction has been followed exhaustively. Action appears first in the anterior part of the axial musculature, and spreads thence tailward through the axial system, and then into the appendicular system, so that before an appendage can act on its own it acts only as an integral part of a whole, which is axial and appendicular. The appendage acquires the ability to act alone by individuation within this total pattern of action.

By way of definition, it should be noted that individuation used in this sense is not the equivalent of specialization or specification, for these processes constitute a functional adjustment of the organism to the environment. Individuation, on the other hand, brings about a definite and peculiar relation of a part of the organism to the organism itself as a whole. Individuation, like integration, is a purely intra-organismic process. It expresses itself, in part at least, through local acceleration of proliferation and differentiation of cells in a relatively equipotential growing system, according to the second neuro-embryologic principle I proposed a moment ago. Furthermore, it conforms to the third principle in the progressive organization from the whole to the part.

In accord, therefore, with these three neuro-embryologic principles—the primacy of a mechanism of total integration, the development of local mechanism by acceleration of growth within a relatively equipotential system and progressive organization from the whole to the part, behavior develops in Amblystoma

104; Carnegie Institution of Washington Publication, No. 380.

[5] J. S. Bolton and J. M. Moyes, "Brain," Vol. 35, Part I.

by the expansion of a primarily integrated total pattern of action and the individuation of partial patterns within the total pattern.

This plan of development is perfectly clear in Amblystoma from the earliest movement through the accomplishment of aquatic and terrestrial locomotion, feeding, optical fixation and the beginning of attention, or the "regarding reaction" of Gesell. This is a matter of fact. Whether or not behavior in other vertebrates follows this plan of development has become a question of leading interest in the study of behavior.

The strongest apparent evidence against this principle as applied to other vertebrates is in the work of Tracy on the toadfish, for he found that the integrated total pattern of action in this animal was preceded by local twitching of myotomes. It has not been demonstrated, however, that these local movements that antedate the total pattern are not myogenic. They give place to the total action pattern before the mechanism of total integration is in physiological connection with the exteroceptive or proprioceptive sensory system. They are, therefore, at no time a factor in a stimulus-response performance in the usual sense, and for that reason can not be reflexes.

The toadfish, it must be remembered, is a highly specialized vertebrate, and these early localized muscular contractions may express a very special adaptation of myogenic, or possibly even neurogenic, response to internal functional needs of the embryo. But even should these early local movements prove to be neurogenic, the situation regarding this principle of behavior would only be analogous to some of those variations in the formation of the germ-layers which are accepted as special adaptations in various species without invalidating the principle of germ-layers as such. Tracy designated these early localized movements as endogenous, but he found that the total pattern of action in the toadfish is also endogenous for a relatively long time before the sensory system "captures" it. Here certainly is a special adaptation to the needs of the particular species, for these early movements of total action serve aeration and respiration in the toadfish.

On the side of affirmative evidence for the validity of the principle of primary total integration in higher vertebrates there are the results of investigations on several species. Among these are the observations by Tuge on the turtle. In this animal, on account of the immobility of the trunk in locomotion, which is effected wholly by the appendages, one would expect to find, if anywhere, local patterns of action as the primary form of behavior. But in the turtle, as in Amblystoma, the earliest movements begin in the region of the head and progress caudad through the axial musculature and out into the limbs, so that the appendages are an integral part of a total pattern before they acquire independence of action.

Further affirmative evidence on the question is found in the embryo of birds. On the chick we have the early and extensive study by Preyer, and the recent exhaustive investigations by Kuo. An analysis of Preyer's records leaves no doubt in my mind that in the chick local action patterns emerge from a total pattern that expands through the growing organism as it does in Amblystoma; and Kuo explicitly indorses this interpretation. It is noteworthy that Kuo used nearly 3,000 embryos in his study on the chick.

The most comprehensive studies on fetal behavior in mammals has been made on the rat by Angulo, who has supplemented exhaustive stenographic notes from immediate observation with motion pictures very extensively. These pictorial records enable him to reexamine any phase of the behavior at any time. By this method he has demonstrated the progressive development of the total action pattern into postural reactions, feeding reactions and the beginning of locomotion. He has also demonstrated the individuation of many local reflexes within the growing total pattern of action.

The fetal behavior of the cat also has been extensively studied by Windle and Griffin. Although endorsing the idea of the total action pattern in general for later fetal behavior, Windle and Griffin express grave doubts concerning its primacy in application to certain early movements which they have observed. These movements, however, are, in my opinion, of the same order as the early localized movements of the toadfish, which are not the beginning of definitive local patterns. Angulo has observed similar movements also in the rat, but he finds that they mark the beginning of asphyxiation and that they do not occur under normal conditions. He does not believe that they should be regarded as the beginning of the behavior pattern as such. Certainly they are neither reflexes nor the beginning of definitive normal local patterns.

There is, also, substantial evidence that in the human fetus local reflexes are preceded by more extensive movements which approximate total reaction. According to the studies of Minkowski and others, a touch on the lip excited movement of the lip and legs in a fetus of 35 mm crown-rump length, whereas it was in a fetus of 110 mm total length that this stimulus excited a local movement of the mouth only. Also, in a fetus of 35 mm, a touch on the eyelid excited movements of the eyelids and legs, although it was in a fetus of 215 mm total length that a pure orbicularis palpebral reflex was first recorded. The plantar re-

flex in a fetus of 75 mm total length consisted of dorsal flexion of the foot and extension of the leg; in a fetus of 100 mm total length, this reflex consisted of movement of the toes only, but all of them in flexion and spreading together; whereas the isolated Babinski reflex was first observed in a fetus of 215 mm total length. It appears, therefore, that these typical reflexes in man develop through individuation out of much more extensive patterns of action.

For these correlations we depend chiefly upon observations by Minkowski, whose studies of the living human fetus have extended through many years. Obviously, however, Minkowski did not have in mind the principle of individuation of partial patterns of action within an integrated total pattern, for this principle has grown out of observations on lower vertebrates in comparatively recent years. It may be expected, on the other hand, that Davenport Hooker and his associates, who have only recently entered this field of study, will be able to test this principle specifically as applied to human behavior in its earliest phases of development.

And we must bear in mind that it is only in the early phases of fetal behavior that the process of individuation within an integrated total pattern can be seen clearly and conclusively. In man this period lies approximately between six weeks and six months of gestation. After six months, the simple local patterns become quickly obscured by complicated reactions, which can be analyzed only by knowing exhaustively what has preceded them in the process of their elaboration. In postnatal life the situation becomes still more complicated, and on the basis of infant behavior alone we can not hope for a clear and conclusive demonstration of the principle of individuation in its simplest terms. Nevertheless, that there is much in infant behavior which accords with the principle is obvious to one who is thoroughly familiar with early fetal behavior by direct observation. One who has exhaustive, immediate, personal acquaintance with the early fetal patterns of action can see in the growing infant up, say, to six months a progressive individuation of smaller out of larger patterns of action; and he can recognize the operation of the principle of individuation in the descriptions of early infant behavior as recorded by several investigators in this field. Especially convincing on this point is the development of the "regarding" reaction and prehension as described by Gesell[6] in infants from six weeks to a year old. The "regarding" reaction, or what may be termed the beginning of attention, is at first only visual fixation, which is effected, as I have already pointed out, by the mechanism of total integration. The reaction then expands through the motor mechanism, bringing head, trunk and arms into action, and finally prehension and grasping of the object of optical fixation is effected by individuation of the adaptive movement out of more general action.

This development of the process of optical fixation and prehension may be taken as a basic example of motor learning, and, in my judgment, the principle that is seen in operation here is involved in all motor learning. In non-motor learning, also, the principle becomes applicable if we bear in mind that knowing is a mode of doing—a thesis that is defended by Dewey[7] and that permeates the psychology of Ogden.[8] It is possible, therefore, that all learning consists of the expansion of a primarily integrated total pattern of action and of individuation of partial patterns within the total system.

Take, for example, the process of association. Since the work of Pavlov, this goes under the name of conditioning. Pavlov considers conditioning as the peculiar function of the cerebral cortex, but typical conditioning occurs in animals which have not even a vestige of a cortex. Conditioning, in fact, may occur in those parts of the brain which are ordinarily regarded as reflex centers. Moreover, the conditioned reflex of postnatal life develops in the same way that the unconditioned reflex develops in prenatal or embryonic life. This common process of development consists in progressive reduction of the reflexogenous zone of stimulation and progressive restriction of the motor response; and both these factors of conditioning or association are expressions of individuation within larger fields of action. This, indeed, seems to be the process through which symbolization and language are learned by the child; and it is probable that these patterns of action developed in the race, also, in the same manner.

Just one other consideration may be presented: the processes of integration of the whole and individuation of parts are antagonistic to each other in the development of behavior. The mechanism of total integration tends to maintain absolute unity and solidarity of the behavior pattern. The development of localized mechanisms tends to disrupt unity and solidarity and to produce independent partial patterns of behavior. In the interest of the welfare of the organism as a whole, partial patterns must not attain complete independence of action; they must be held under control by the mechanism of total integration. Parts become integrated with each other because they are integral factors of a primarily integrated whole,

[6] Arnold Gesell, "The Individual in Infancy," "The Foundations of Experimental Psychology," Chapter 16, Worcester, Mass., 1929.

[7] John Dewey, "The Quest for Certainty: A Study of the Relation of Knowledge and Action." New York, 1929.

[8] R. M. Ogden and F. S. Freeman, "Psychology and Education." New York, 1932.

and they remain integrated, and behavior is normal, so long as this wholeness is maintained. But the wholeness may be lost through a decline of the mechanism of total integration or through the hypertrophy of mechanisms of partial patterns. This, I believe, is the biologic basis of that conflict in behavior which expresses itself widely in the field of psychopathology.

So much for the principles and the perspective of the neuro-embryologic study of behavior. What, now, of its aim? Of this I shall speak chiefly in the negative sense.

Certainly I have not at any time entertained the thought that it might be possible to explain every footprint of the action pattern of an animal in terms of the development of its nervous system; but I have from the beginning hoped that this method of treatment might throw a new light upon the important highways of behavior. This, I believe, has already been accomplished in the field of lower vertebrates, while here and there the same light is beginning to filter through upon the realm of higher animals and man. Nevertheless, even in lower forms there are many byways of behavior still to be explored with this method, and the whole subject of neuro-embryology of higher vertebrates should be reexamined in the light of the principles now well established for lower forms.

Furthermore, while I do not expect this method of study to explain all behavior in neurological terms, neither do I expect it to give a final explanation of anything in behavior. I recognize that a purely scientific discipline does not deal with the essence of things, the ultimate, or things immutable. The data of science are relational. Motion is a primary datum of science. For science, force is not an ultimate or immutable cause of motion; it is a space-time relation.

The long-prevailing confusion of metaphysics with scientific thought John Dewey[9] lays at the door of Newtonian physics. He holds that the Newtonian system is grounded in metaphysics, for its primary postulate is the immutability of particulate matter, a purely metaphysical concept. Obviously, in a system of immutable substance, force must be an agency of change in relations. In such a confusion of science and metaphysics, the mechanistic theory of behavior has its origin, with Newtonian immutability at its heart. This is the pitfall of the mechanistic doctrine, for it treats the organism as a succession of static space-relations which are transformed each into the succeeding by some immutable agency acting upon them. Consequently, Dewey's evaluation of Newtonian physics applies equally to mechanistic behaviorism; it is essentially metaphysical.

[9] John Dewey, *loc. cit.*

According to current thought, nothing is static; everything exists not only in a "frame" of space but also in a pattern of time. It becomes, then, a question not of matter *and* motion, but of matter *in* motion. Neither is it a question of structure *and* function; but it is a condition of structure *in* function; for all structure is in action, and the action of a structure is its function. Argument as to whether structure precedes function or function precedes structure, or in other terms, whether structure *causes* function or function *causes* structure is beside the mark, for neither can exist without the other at any point in space or time: they merge, in fact, into a space-time relation. Accordingly, if we think structure as static, we can attain in science only description that is infiltrated with metaphysics in the form of an anthropomorphic and mystical conception of cause and effect; but if we think structure *in* function as a space-time relation, as we must in a purely scientific discipline, we may hope to attain to all the understanding of behavior that science has to offer.

The embryological method illustrates the distinction I am trying to make. It has transformed anatomy into a science, in so far as it has correlated time-relations with the space-relations which constituted the anatomy of other days. Also, it is now engaged in a similar transformation of physiology through the contribution of such concepts as totipotence, pleuripotence, organizers, gradients, all of which have meaning only as the organism is regarded, not as a static pattern in space, but as a dynamic pattern in time. So, again, with the problem of behavior, which was formerly chained to the concept of the organism as a static pattern—involving physiological activity, of course, but being essentially the same in that activity at all times. The embryological method, on the contrary, reveals the behavior of the individual as a progressively changing continuum in which from beginning to end any particular pattern can be fully perceived only in the light of what precedes and follows.

In the sphere of living things, events are cyclic, and the organismic cycle, unlike the cosmic, lies within the life-span of man as an observer. For this reason, the living organism should constitute both the most available and the most conclusive information for the interpretation of those relations within a system which, according to the scientific method pure and simple, may be called cause and effect. Regarding this conception, the neuro-embryologic study of behavior shows that events within a behavioral system can be understood scientifically only as their relation is known to subsequent as well as to antecedent phases of the cycle. The antecedent tells a part of the story about the present, but not all of it; for within the present are events that have behavioral significance

only in that which follows. Call this vitalism, if you will; I do not, for objection to it can not be grounded in any violation or contradiction of the scientific or the experimental method. It meets opposition only in that unconscious, or subconscious, mysticism which is the source of our concept of cause and effect. The purely scientific method, dealing exclusively as it does with space-time relations, can not reject the future from its explanation of the present in behavior, because any event in an organismic cyclic system is an integral part of both the future and the past. Whatever time may be in the absolute, as a function in behavior it works backward as well as forward. Working forward it is memory; working backward it is anticipation or imagination. In fact, one might say that, other things being equal, the position of an organism in the scale of behavior is directly correlated with the degree to which the past and the future are integrated with its present.

In this statement I am distinguishing between absolute time and time as a function in behavior, or between metaphysical postulate and scientific method. This distinction appeals to me as useful in clearing the way for an unadulterated science of behavior.

In closing a series of lectures on "The Moral Ideal," the late James Seth, who was finally professor of metaphysics in the University of Edinburgh, appealed to his class of young men in these words: "I would remind you how much greater is our life itself than any philosophy of it can ever be. By the very nature of the case, philosophy must always be disappointing; and from its abstract formula we turn with relief to literature, and, above all, to the tasks of life itself—from the discords of the schools to the great unanimities of life. The true insight into the meaning of life is as much moral as intellectual: it is the obedience of the will that clarifies the intellect. And if we have found the difficulty of a philosophic definition of the moral ideal, let us remember that the true definition is that of life itself."

This was the plea of a great metaphysician for the validity and supremacy of living in charting a philosophy of life. From such metaphysics there can be nothing to fear in regard to the survival of life's practical values. But every one of us is in his own way a philosopher, and my fear is that by the covert filtration of our peculiar philosophy into our science of life we may destroy the sources of the sweetness, the richness and the "great unanimities" of living. My own working hypothesis holds that the relation of cause and effect, in a purely scientific discipline, is a space-time relation within a unitary system, that the living organism is such a system, and that I can not fully perceive any phase of this relation or part of this system without perceiving the system as a whole. Upon this hypothesis my understanding of an event scientifically or experimentally requires knowledge of the future as well as of the past of the system in which that event occurs. If this be philosophy, I would call it a philosophy, not of *being,* but of *becoming;* not of *life,* but of *living*—which is itself my supreme experiment.

SCIENTIFIC EVENTS

THE INTERNATIONAL ORNITHOLOGICAL CONGRESS

Nature reports that the eighth International Ornithological Congress is to be held at the University of Oxford in July, 1934, under the presidency of Dr. E. Stresemann, of Berlin. The congress was originally held every five years, but at the last meeting at Amsterdam in 1930, when the president was Dr. E. Lönnberg, of Sweden, it was decided to hold it every four years. The last meeting of the congress in England was at the Imperial Institute, London, in 1905, with Dr. R. B. Sharpe as president. In 1910 it was held in Berlin, and it was proposed to hold the 1915 congress at Sarajevo, Yugoslavia, but in the meantime the war broke out and no further meeting was held until 1926, when, mainly through the efforts of Dr. Ernst Hartert, keeper at Tring Museum, it was resumed at Copenhagen. Preliminary arrangements have already been made for the 1934 congress at Oxford, and the Rev. F. C. R. Jourdain, of the British Ornithologists' Union, has been elected honorary secretary. Dr. P. R. Lowe, of the British Museum, has been elected chairman of the executive committee, which includes Lord Rothschild, Lord Scone, Dr. C. B. Ticehurst, Dr. Sclater and Messrs. Stuart-Baker and H. F. Witherby, president of the British Ornithologists' Union.

Delegates to the congress will include, according to *Nature,* the leading ornithologists from all parts of the world, including Australia, New Zealand, Argentina, Brazil, Japan, India, the United States, Canada and all European countries. The problem of oil pollution of the sea, whereby hundreds of sea-birds, including many rare species, are annually being destroyed, especially on the North Atlantic shores, will be a prominent feature of the section on bird protection, while the practise of "ringing" as a means of tracing bird migrations will also be discussed. One of the most important items is the project for founding an Institute of Ornithology at the University of Oxford, which it is hoped to develop out of the existing scheme of research in economic ornithology at Oxford, the grant for which expires in September,

1933. The new institute is intended to be a national center for field ornithologists as the British Museum is for systematists. £8,000 is needed to run the institute for a preliminary five years while steps are being taken to put it on a more permanent basis. An appeal will be made not only for funds but also for gifts of books, field notes and photographs, etc., for equipping it. It is also proposed to arrange at least one long excursion to study British bird life, and South Wales will probably be chosen as the area to visit, though several shorter excursions are to be made. The lectures and papers are to be given in English, French, German and Italian.

THE FIRST TEN YEARS OF THE NORTHEASTERN FOREST EXPERIMENT STATION

JULY 1, 1933, marked the tenth birthday of the Northeastern Forest Experiment Station, which serves all New England and New York. During its first ten years the station has established itself in the region as an agency for leadership and coordination in the advancement of technical forestry practises and has made notable contributions to the knowledge of forest management.

Starting in 1923 with four technical men and a clerk, the station had twelve technical men and five clerks on its staff during its tenth year, including, in addition to the Forest Service men, representatives of the Bureaus of Plant Industry, Entomology and Biological Survey. Originally occupying offices at the Massachusetts Agricultural College, at Amherst, the station moved its headquarters in 1932 to New Haven, Connecticut, where a building was made available by Yale University.

Since its establishment the station has had the advice and help of the Northeastern Forest Research Council, which is composed of representative forest land owners, business men, educators, state forest officials and others interested in the development of the forest resources of the region.

Much of the work of the Northeastern Station has consisted of the establishment, treatment and subsequent remeasurement of permanent sample plots, the number of which has now reached 545, involving altogether about 437 acres. These long-time experiments are being concentrated in so far as practicable on a few representative areas. Two experimental forests, together comprising about 4,000 acres, have been set aside for this purpose in the White Mountain National Forest, New Hampshire, and cooperative agreements have been entered into for the use of two other areas of between 500 and 600 acres each in New York State. Continuous meteorological records are being obtained on the experimental forests in the White Mountains and intensive development of these areas is being pushed through federal unemployment relief activities.

The station's research program has covered in a broad way the following subjects: growth and yield of spruce and fir, management of spruce and fir for pulpwood production, decay of slash, deterioration of birch on cut-over lands, development of form class volume tables, analysis of forest fire statistics, relation of weather to inflammability of forest fuels; control of spruce budworm, white pine weevil, European larch canker and other forest insects and diseases, relation of light and soil moisture to tree growth, growth and yield of northern hardwoods, forest planting and phenology of forest trees and shrubs. A list of the major publications of the staff of the station during the past ten years would include 85 titles, comprising about 1,300 printed pages.

Although the station's activities have covered a variety of subjects there is need for a still more comprehensive program. It is perhaps most urgent at this time that provision be made for a systematic survey of the forest resources of the region and for studies in the field of the economics of forestry. Basic knowledge is also needed on how various types of growth and methods of forest management influence the quantity and quality of water supplies, and the character and abundance of game and wild life in the forest. It is apparent that, because of the long-time element in forestry and the diversity of the problems demanding attention, it will be difficult to keep the advance of knowledge ahead of the actual need for results.—*C. Edward Behre, director.*

THE COST OF GERMAN MEDICAL AND SCIENTIFIC PERIODICALS

THE Medical Library Association, including 156 American and 6 Canadian libraries, in convention assembled in Chicago, June 19, 1933, passed the following resolutions:

1. It is recommended that no library subscribe to any periodicals that do not have a fixed annual subscription price for the entire annual output of volumes or parts. That such price be stated in advance, and also a statement of the number and parts to be issued per year.

2. That the Committee on the Cost of Current Medical Periodicals be empowered to invite the various library groups of this and other countries to cooperate with us in the above-mentioned and other measures, necessary to establish more equitable prices for medical and other scientific journals, and that the approach to library organizations in other countries be made first through the president of the International Federation of Library Associations.

3. We believe there is wide-spread opinion that there must be a substantial reduction in extent of, and in subscription prices for, the most expensive medical and other scientific periodicals, and we further recommend that, un-

less definite word to this effect is received sufficiently prior to renewal of subscriptions for 1934, libraries cancel their subscriptions to the most expensive journals, except one library in each of 6 to 10 zones throughout the United States and Canada.

Miss Marjorie J. Darrach, secretary of the association, writes:

These resolutions were passed on the recommendations of the Committee on the Cost of Current Medical Periodicals, which has been studying this question intensively during the past year.

It is felt that these recommendations are advisable, as their fulfillment is essential to the efficient and economic administration of libraries; and it should be pointed out that they are not in any sense of national significance, nor do they in any way constitute an unfriendly gesture to any group of scientists. They are strictly of an economic nature, and are designed to meet certain unfortunate existing conditions which constitute a hindrance to the free interchange of scientific thought.

It is understood that conferences in regard to this situation are to take place in Europe this summer, and there have been unofficial promises made that the conditions complained of will be remedied in the near future. In order, therefore, to give editors and publishers a reasonable amount of time to cooperate, the recommendations cited above do not become effective until it has been demonstrated whether the results of these conferences and negotiations have failed. Therefore, decisions regarding subscriptions for 1934 are being postponed until November 1, 1933, pending the outcome of negotiations.

THE FINANCIAL SITUATION OF THE DEPARTMENT OF AGRICULTURE

IT is reported by Science Service that the proposed twenty-five per cent. reduction in funds for the extension service and experiment stations of the U. S. Department of Agriculture, and the funds for land grant colleges and vocational education has been again deferred by executive order of President Roosevelt. This time the effective date is deferred until sixty days after the opening of the next session of the Congress, which will be about March 1, 1934. This order probably saves $3,917,000 for education and research, particularly in agriculture.

Officials of the Department of Agriculture are not yet certain of the proper interpretation of the order. The effective date now occurs after all payments for the extension service have been made for the present fiscal year, and all but one of the payments for the experiment stations. If the cut is to apply to the whole of the fiscal year it will mean that a refund must be made.

The personnel of the Department of Agriculture has been greatly reduced, as shown by a tabulation of dismissals, furloughs and positions abolished, compiled by Dr. W. W. Stockberger, of the department. More than a thousand persons have been separated from the different bureaus since the first of March. With the additional separations that it is estimated were made during the month of July the total number will reach 1,530. Of these, 233 were engaged in scientific research, including 42 in the professional grades.

During the past year in cases where resignations or vacancies have occurred positions have been left unfilled. Such positions to the number of 407 were abolished at the beginning of the fiscal year.

The work of the department will also be curtailed through furloughs. It is estimated that during the present fiscal year 2,141 persons will be furloughed for periods ranging from one week to a year. The total number dismissed, furloughed or whose positions have been abolished amounts to over 4,000. A considerable number, however, has been given employment in connection with the new recovery agencies under the control of the department.

THE CHICAGO MEETING OF THE AMERICAN CHEMICAL SOCIETY

SCIENTIFIC men of America and Europe will unite in an international tribute to Dr. Richard Willstätter, of Munich, at the eighty-sixth meeting of the American Chemical Society. The meeting, under the presidency of Professor Arthur B. Lamb, of Harvard University, will be held in Chicago in connection with the Century of Progress Exposition from September 10 to 15.

More than 3,000 men and women of science, said to be the largest number ever to attend a convention of the society, are expected to participate. Addresses will be delivered by Dr. Willstätter; Professor George Barger, of the University of Edinburgh; Professor J. N. Brønsted, of the University of Copenhagen, and Dr. Paul Karrer, of Zurich. Practically every professional division of the society will be represented. The fields to be covered include industry, agriculture and food, medicine, gas and fuel, public health, education, petroleum, dyes, rubber, sugar, water, sewage and sanitation.

The central event will be the presentation on Wednesday evening, September 13, of the Willard Gibbs Medal to Dr. Willstätter, who was Nobel Prize Laureate in chemistry in 1925. This is one of the highest honors in American chemical science, and is awarded annually by the Chicago section. At the medal ceremony Dr. Willstätter, dealing with popular aspects of chemistry, will speak on "One Chemist's Retrospects and Prospects." He will deliver the formal medal address on Thursday afternoon, September 14, at a symposium before the sections of organic chemistry, biochemistry and medicinal chemistry, on "Recent Advances in the Nature of En-

zymes." Professor Karrer and Professor Barger will also speak.

An account of Dr. Willstätter's work, for which the medal has been awarded, will be found in the issue of SCIENCE for April 21, 1933.

Professor George Barger, who occupies the chair of medicinal chemistry at the University of Edinburgh, has devoted himself especially to the study of substances of biological and pharmacological interest. In 1928 he was Baker lecturer at Cornell University and Dohme lecturer at the Johns Hopkins University. Professor Karrer has confined his research during recent years chiefly to the pigments of plants and vitamins. Professor Brønsted works at the Physical-Chemical Institute in Copenhagen. He is at present studying the theory of acids and bases, as well as the general theory of solutions. Professors Brønsted and Willstätter are lecturing in Spain during August and are expected to reach New York early in September.

The American Chemical Society award in pure chemistry of $1,000, established in 1931 by Dr. A. C. Langmuir, "in recognition of the accomplishment in America of outstanding chemical research by a young man or woman less than thirty years old, preferably working in a college or university," will be presented to Dr. Frank H. Spedding, of the University of California. Dr. Spedding will address the Division of Physical and Inorganic Chemistry on "Energy Levels in Solids." This prize was awarded in 1931 to Dr. Linus Pauling, now professor of chemistry in the California Institute of Technology, and in 1932 to Dr. Oscar K. Rice, instructor in chemistry at Harvard University.

The annual presidential address will be delivered by Professor Lamb on the evening of September 14.

SCIENTIFIC NOTES AND NEWS

DR. JAMES BRYANT CONANT, president of Harvard University, previously Sheldon Emery professor of organic chemistry, has been elected an honorary fellow of Emmanuel College, Cambridge.

THE Baly Medal of the Royal College of Physicians, awarded every alternate year to the person who shall be deemed to have most distinguished himself in the science of physiology during the two years immediately preceding, has been awarded to Dr. Robert Robison, of the Lister Institute, for his work on the esters of phosphoric acid and the enzyme phosphatase and the part they play in bone metabolism. The Weber-Parkes Prize and Medal for the best work done in connection with the etiology, prevention, pathology or treatment of tuberculosis has been awarded to Sir John McFadyean.

AT the recent annual meeting of the National Tuberculosis Association in Toronto the Trudeau Medal was awarded to Dr. Lawrason Brown, who since 1900 has been associated with the Trudeau Sanatorium, Saranac Lake, New York.

AT the commencement exercises of Columbia University a University Medal for excellence was presented to Dr. Henry Dwight Chapin, emeritus professor of diseases of children, New York Post-Graduate Medical School and Hospital, New York. The medal was awarded to Dr. Chapin in recognition "of his outstanding contribution to problems relating to the care of children."

THE prize of 10,000 francs, established by a legacy of the Prince of Monaco, to be awarded every two years by the Paris Academy of Medicine to a scientific man whose career has been characterized by medical discoveries, has been bestowed on Dr. Héricourt, who was the collaborator of Charles Richet in the introduction of serotherapy.

THE London School of Hygiene and Tropical Medicine has received from W. J. Courtauld a munificent gift for the tropical side of the work of the school. In recognition of this gift the Senate of the University of London has conferred upon Professor R. T. Leiper the title of William Julien Courtauld professor of helminthology.

PROFESSOR ALBERT EINSTEIN has informed the Jewish Telegraphic Agency, with regard to reports of his acceptance of invitations to the University of Madrid and the Collège de France, that he bound himself a year ago to spend the winter half-year in future at Princeton conducting his scientific work at the Institute for Advanced Study. Reports of his acceptance of teaching posts at other universities are not in accordance with the facts.

HARRY STANLEY ROGERS, dean of engineering at Oregon State College, has been elected fifth president of the Polytechnic Institute of Brooklyn. He succeeds Dr. Parke R. Kolbe, who resigned a year ago to become president of Drexel Institute.

AT the Ohio State University, as part of economies necessitated by a further decrease in state appropriations, salaries have been reduced from three to ten per cent. Seventy-three members of the teaching and non-academic staffs have been put on part-time service and 236 positions have been abolished. Among members of the faculty who have retired are Professor William T. Magruder, mechanical engineering;

Professor Herbert Osborn, entomology, and Associate Professor E. P. Durrant, physiology.

DR. HAROLD L. AMOSS, professor of medicine at Duke University School of Medicine, since the establishment of the school in 1930, has resigned to enter private practise at Greenwich, Connecticut, and conduct research at the Rockefeller Institute for Medical Research. Dr. Frederic M. Hanes, who has served as professor of neurology at Duke University during the past year, has been appointed to succeed Dr. Amoss.

DR. CHARLES N. MEADER, dean emeritus of the University of Colorado School of Medicine, Denver, has resigned as head of the department of medicine. Dr. James J. Waring has been appointed professor and head of the department to succeed Dr. Meader.

GORDON H. PRITHAM, who has finished his work for the Ph.D. degree in the department of agricultural and biological chemistry at the Pennsylvania State College, has been appointed assistant professor in charge of physiological chemistry and research at St. Thomas College, Scranton, Pennsylvania.

THE resignation is announced of Dr. Walter G. Sackett, since 1908 bacteriologist at the Colorado Experiment Station at Fort Collins.

AT University College, Nottingham, Dr. Harry Cotton has been appointed to the newly created chair of electrical engineering.

W. W. JERVIS, reader in geography in the University of Bristol, has been appointed first professor of the subject there.

W. A. ROBERTSON, Indian Forest Service, retired, has been appointed director of forest products research under the British Department of Scientific and Industrial Research, in succession to Sir Ralph S. Pearson, who retires on September 30.

AT the recent annual general meeting of the Museums Association at Norwich, England, Dr. Cyril Fox, director of the National Museum of Wales, was elected president, and E. C. Chubb, director of the Durban Museum and Art Gallery, and Lord Crawford and Balcarres were elected vice-presidents.

THE following appointments of lecturers have been announced by the Royal College of Physicians: Dr. J. Collier, Harveian orator, 1934 (the forthcoming Harveian oration in October next will be delivered by Sir Thomas Lewis); Dr. J. H. Sheldon, Bradshaw lecturer, 1934; Dr. H. L. Tidy, Lumleian lecturer, 1934; Dr. E. C. Dodds, Goulstonian lecturer, 1934; Dr. C. H. Andrewes, Oliver-Sharpey lecturer, 1934; Sir Humphry Rolleston, Bt., FitzPatrick lecturer, 1934, and Dr. E. I. Spriggs, Croonian lecturer, 1935.

HERMAN G. BAITY, dean of the engineering school of the University of North Carolina, was recently appointed by President Roosevelt to be a member of the North Carolina State Advisory Board on Public Works.

PROFESSOR H. R. TOLLEY, director of the Giannini Foundation of the University of California, is in Washington, D. C., to assist in the administration of the National Farm Relief Act.

THE election of E. J. Rutan, superintendent of the testing department of the New York Edison Company, to the chairmanship of the recently organized Sectional Committee on Electrical Measuring Instruments is announced by the American Standards Association. H. C. Koenig, of the Electrical Testing Laboratories, New York, was elected secretary of the committee. The work of the committee will be handled by two subcommittees, one on definitions, and the other on classification, rating, methods of testing and construction.

DR. E. A. FATH, chairman of the department of astronomy at Carleton College, has been given leave of absence for a year, which he will spend in research at Lick Observatory.

PROFESSOR CHENFU WU, of Yenching University, Peiping, has been granted a traveling professorship by the Rockefeller Foundation for the year 1933-34 to complete his catalogue of Chinese insects. He will spend part of his time at Cornell University and the rest visiting museums in England and on the Continent. Professor Chihwei Luh, also of Yenching University, who has been awarded a fellowship by the China Foundation, has leave of absence for the year 1933–1934, which he will spend at the University of Chicago for further work in neuroanatomy and psychology.

AT the eighth annual meeting and dinner of the Peking Society of Natural History, held on April 28, Dr. H. H. Hu, of the Fan Memorial Institute of Biology, was elected president to serve for the year 1933–34. At the same meeting announcement was made of the election of Dr. Sven Hedin as an honorary member of the society. On this occasion the King senior medal was awarded to Dr. C. Ping, director of the Biological Laboratory of the Science Society, Nanking, in recognition of his work on paleozoological subjects and also of his work as a teacher of Chinese students.

RECEIPT of a fund of $300 to pay for the first season of a new series of lectures on geology and geography at Northwestern University has been announced by Dr. W. H. Haas, professor of geology and geography at the university. The lectures are to

be known as the U. S. Grant memorial lectures in honor of the late Professor U. S. Grant, formerly head of Northwestern's department of geology and geography. The first lectures, to be delivered probably next November, will be given by Dr. W. H. Collins, director of the Canadian Geological Survey. A gift of $150 for a scholarship to be known as the Grant graduate scholarship in geology and geography is also announced. The donors of both the lecture fund and the scholarship will for the present remain anonymous.

ACCORDING to the *Journal* of the American Medical Association, the William A. Johnson Memorial Medical Building at Wake Forest College School of Medicine, a gift of the family of Dr. Johnson, who was killed in an automobile accident in 1927, has been completed and turned over to the school. The new structure, built at a cost of $60,000, is three stories high and contains adequate teaching and research facilities. Dr. Johnson received his academic degree at Wake Forest and after graduating from the University of Pennsylvania School of Medicine in 1925 returned as professor of anatomy, which position he occupied at the time of his death.

APPLICATIONS for the positions of associate dye technologist, marine engineer, associate marine engineer and assistant marine engineer must be on file with the U. S. Civil Service Commission at Washington, D. C., not later than September 7, 1933. The entrance salaries for these positions range from $2,600 to $4,600 a year, less a deduction of not to exceed 15 per cent. as a measure of economy and a retirement deduction of 3½ per cent. Competitors will not be required to report for a written examination, but will be rated on their education and experience.

ACCORDING to Science Service, part of the $15,982,745 allotted to the U. S. Forest Service from federal public works funds will be used for research. It is planned to make a nation-wide survey of the country's forest resources, to be financed from this fund. Research will also be aided indirectly through the improvement of the experimental forests, which are the field laboratories of the forest experiment stations, and the improvement of equipment in the Forest Products Laboratory of the Forest Service. The principal part of the fund, however, will go for construction work and the control of insects destructive to timber and the control of the white pine blister rust.

THE *Journal* of the American Medical Association reports that expenditures of the U. S. Public Health Service for the fiscal year which began July 1 will be reduced from $10,380,328 originally appropriated by Congress to $7,860,000 by order of the Bureau of the Budget. Essential activities of the service will be maintained, although some will be curtailed. Of 376 commissioned medical officers, twenty-one were placed on the retired list, three discharged and one resigned. Quarantine and immigration activities in foreign countries have been reduced with the discharge of ten American physicians stationed outside the United States. Those who remained suffered reductions in compensation, as did most of the 700 acting assistant surgeons on part-time service within the country. The appropriation for twenty-six marine hospitals and about twenty field relief stations was reduced from $5,600,000 to $4,420,000, a reduction partly met by economies in operation. Financial aid to county health units in twenty-eight states will be discontinued. Some of the units will be maintained by the counties and states, but many will probably be abandoned. Funds of the division of scientific research were cut 50 per cent., a reduction that was taken up in operation economies. Payless furloughs of two days a month will meet a similar cut in the maritime quarantine division. The division of mental hygiene will delay for one month the opening of service in new institutions in Detroit, Springfield, Mo., and Oklahoma. Altogether thirteen employees were discontinued in the Washington office, 650 at field stations and 310 engaged in rural sanitation. Twenty-five were placed on indefinite furlough and 1,500 others will take five days off without pay each month.

To secure specimens and natural accessories for a moose group to be erected in North American Hall in the Free Natural History Museum of the Academy of Natural Sciences, Philadelphia, Nicholas Biddle, accompanied by Harold T. Green, curator of museum exhibits in the academy, left on August 7 for Alaska. By way of Seattle they will go to Seward, and from there by pack train into the wild regions of the Kenai Peninsula. The expedition expects to return to Philadelphia early in October. The Kenai moose is the largest of its kind in the world, the horn spread of the bulls often running between five and six feet. In addition to the specimens secured, color sketches and photographs will be made to assure accuracies of color and scenery in the painted background for the group, and Mr. Green will collect trees, shrubs, mosses and stones from the locality in which the specimens are secured.

Nature reports that the Botanical Institute of the Soviet Academy of Science has completed a work in twenty volumes on "The Flora of the U.S.S.R." The work has been compiled under the guidance of V. L. Komarov, vice-president of the academy, and is founded on the rich herbarium of the Botanical Institute, including more than 20,000 kinds of plants. The early volumes of the work are in type and will shortly be published.

THE Eugenics Research Association, Cold Spring Harbor, Long Island, N. Y., offers a first prize of $3,000 and a second prize of $1,000 for original researches on the "probability of commitment for a mental disorder of any kind, based on the individual's family history." It is to be clearly understood that the probability of commitment to an institution is the criterion upon which the research must hinge. But contestants are at liberty to pursue without prejudice their own technique in making their investigations. Typewritten and adequate reports of such studies are to be presented to the Eugenics Research Association on or before July 1, 1935. The text of the prize-winning researches will be published in book form by the association.

SECRETARY SINGSON ENCARNACION, of the Department of Agriculture and Commerce, Government of the Philippine Islands, has appointed Dr. Leopoldo A. Faustino, Ph.D. (Stanford), chief geologist of the Bureau of Science, as chief of the National Museum Division of the bureau. The exhibits of the National Museum Division are housed in two buildings. The Museum of Natural History in the Bureau of Science Building, Ermita, contains exhibits of Philippine archeology and ethnography, birds, fishes, shells, corals, mammals and reptiles, insects, rocks and minerals, mineral products, plants, organic products, preserved fruits, fishing appliances, mine models, etc. The Industrial Museum, Port Area, has exhibits of lumber, bamboo, rattan, resins, gums and other forest products, products and by-products of sugar cane, coconut, rice, tobacco and abaca; the embroidery, hat, leather, distillery, textile and pharmaceutical industries, etc.

DISCUSSION

THE UNIVERSITY OF CALIFORNIA BOTANICAL GARDEN EXPEDITION TO WESTERN CHINA AND TIBET

IN the April 28 issue of SCIENCE, some account was given of a recent expedition to western China and Tibet. My attention has been called to certain misapprehensions created by this article as to the character of the expedition and the auspices under which it was carried on.

Some years ago, a large sum of money was contributed by friends of the University of California Botanical Garden to purchase a representative collection of Rhododendron species and to establish a fund for its maintenance. To enrich this collection, the University of California requested Dr. Jos. F. Rock, the well-known plant explorer in Asia, to conduct an expedition into southeastern Tibet, Yunnan and Szechuan provinces, China, where in the past many new or little known species of Rhododendron were obtained by him and by Wilson, Forrest, Farrer and Kingdon Ward. Because of his interest in the university's Rhododendron collection, Dr. Rock generously agreed to donate his own services and the use of his equipment if the University of California could provide funds for the hire and maintenance of native collectors and pack trains and the transportation of the products of the expedition to Berkeley. Initial pledges of support from friends of the university justified the authorization to Dr. Rock to proceed according to plans mutually agreed upon. The expedition was officially designated "The University of California Botanical Garden Expedition in Western China and Tibet," and a considerable sum was secured from organizations and individuals anxious to contribute to the development of a representative botanical garden at the University of California.

Because of economic conditions, it was not possible to complete the expedition fund through local contributions, and as a result, botanical and other institutions, as well as individuals in this country and in England, were appealed to, primarily on the ground that the expedition should yield material of scientific importance to all botanists. At the present time over thirty names are included on the list of sponsors of the expedition.

Although the expedition emphasized the securing of new or little known species of Rhododendron and of other woody ornamentals, Dr. Rock was asked to collect at least herbarium specimens of all plants found. The wealth of material received will make possible important contributions to the knowledge of the botany of the regions in which his four collecting parties worked during the flowering and fruiting seasons of 1932. The preliminary estimate made by Dr. Rock of the number and character of the seed and herbarium specimens collected was included in a popular description of the expedition published in the *California Alumni Monthly* (May, 1933). Since the unpacking of the collections in Berkeley did not begin until April first, and since over 25,000 herbarium specimens and seed of more than 1,350 numbers (over 75 genera) were obtained, it will be some months before accurate information as to the character of the products of the expedition will be available. Based upon determinations which are being made by specialists in this country and abroad, a check list is being prepared for publication.

T. H. GOODSPEED

UNIVERSITY OF CALIFORNIA

SODIUM TETRATHIONATE AND METHYLENE BLUE IN CYANIDE AND CARBON MONOXIDE POISONING

HYDROCYANIC acid or compounds capable of liberating hydrocyanic acid are, in the light of our present knowledge, the sole toxic principles of the poisonous plant arrow grass (*Triglochin maritima*). In this laboratory various agents have been tried in some preliminary work relative to the procuring of a satisfactory antidote for cyanides. According to published bibliographies the effective treatment of cyanide poisoning by methylene blue in laboratory animals has been known for some time. In 1932 a human case of cyanide poisoning was successfully treated at the University of California. Recently Foresti[1] has reported that sodium tetrathionate is an effective antidote for cyanide poisoning.

Of the various antidotes advocated to treat cyanide poisoning two, according to results in this laboratory, are quite effective. A dose of three to four milligrams of a hydrocyanic acid solution per kilogram of body weight is fatal for the rabbit when administered orally. The intravenous injection of two to three milliliters of a 2 per cent. solution of sodium tetrathionate per kilogram of body weight is effective in saving rabbits having received orally three times the minimal lethal dose of hydrocyanic acid (10 milligrams per kilogram of body weight). The sodium tetrathionate solution is administered with the onset of the first symptoms of cyanide poisoning. Rabbits tolerate three times the above therapeutic quantity of tetrathionate without exhibiting any toxic effects.

Methylene blue administered intravenously in the form of a 1 per cent. aqueous solution does not afford quite as much protection. Rabbits receiving more than two times the minimal lethal dose (more than six or seven milligrams of hydrocyanic acid per kilogram of body weight) could not be saved. The intravenous injection of quantities in excess of 2.5 cc of a 1 per cent. solution of methylene blue was injurious to the rabbit.

The results obtained with the use of sodium tetrathionate in cyanide poisoning suggested a trial of the effectiveness of this salt in other types of poisoning, particularly that due to carbon monoxide. Rabbits were placed in a special gas chamber arranged so that the supply of air (that is, the oxygen source) and the concentration of carbon monoxide could be regulated. The animals were gassed to a point from which recovery was impossible without treatment. Sodium tetrathionate is more effective than methylene blue in reviving the animals poisoned with this gas. Animals can be revived from definitely more severe stages of carbon monoxide poisoning with tetrathionate than with the methylene blue.

Carbon monoxide will always be more or less of a serious source of poisoning so long as the automobile, the illuminating gas and the coal-burning appliances are used by man.

This laboratory confines its work to the study and treatment of plant poisoning in live stock. These observations on the effectiveness of sodium tetrathionate in treating carbon monoxide poisoning are produced here in the hope that it may be given due study and trial by those who are called upon to treat human cases of carbon monoxide poisoning. There are no greater achievements of man than the saving of human life.

Mr. C. S. Gilbert has kindly prepared very pure sodium tetrathionate and has helped in the construction and manipulation of the gas chamber.

JOHN H. DRAIZE
THE AGRICULTURAL EXPERIMENT STATION
UNIVERSITY OF WYOMING

[1] B. Foresti, *L'Ateneo parmense*, Vol. 3, No. 6 (1931), through *Chem. Abst.*, Vol. 26, p. 5662.

THE OCCURRENCE OF IXODES AURITULUS NEUM. IN NORTH AMERICA (OREGON)

THE type locality for *Ixodes auritulus* is recorded as the Straits of Magellan, South America. Neumann's four type specimens were taken from an unidentified bird, and two additional females in the British Museum came from the South American blackbird, *Trupialis militaris*. It is of interest, therefore, to record the recovery of a single, fully engorged female tick of this species from an English sparrow (*Passer domesticus*) near Hebo, Oregon, on August 25, 1932. The specimen was forwarded through the kindness of Mr. H. E. Staples.

Comparison with the description of this species as given by Nuttall and Warburton[1] in their Monograph of the genus shows an almost precise agreement with the characters as listed. The anterior projection of article one of the palpae is very distinct. Measurements agree almost exactly, except that the scutum is not quite one and one half millimeters in length; the shape of the latter agrees with the remarks of the above authors in being "more angular" on the sides than in Neumann's figure of the type. This specimen also lacks the yellow suffusion between the cervical grooves, although there is a faint indication of it anteriorly. The characters of the hypostome are obscured by adherent tissues, but it is otherwise in a well-preserved condition.

[1] G. H. F. Nuttall and C. Warburton, "Ticks—A Monograph of the Ixodoidea," Part II. Cambridge University Press, 1911.

This is the first known record of its occurrence in North America. It is possible that the species has been introduced on some migratory bird.

C. B. PHILIP

U. S. PUBLIC HEALTH SERVICE,
HAMILTON, MONTANA

PROTECTIVE AMPUTATION OF LIMBS BY STAGOMANTIS CAROLINA

(DEVIL'S WALKING STICK, DARNING NEEDLE OR HORSE)

AN adult form was observed in Columbia, Missouri, in July, 1932, on a sugar pear tree, in a state of quiescence with his feelers shielded by the fore legs. An attempt was made to move it to another place by grasping the fore limbs with thumb and finger, but they at touch, were shed—the two points of separation exuding droplets of greenish liquid. Acting upon humanitarian impulses, the insect was decapitated with a sharp knife. Then carrying out the intention of moving it from the tree—the right hind limb was lightly grasped by thumb and finger, and this too was shed as in the case of the fore limbs. The procedure was then repeated with the left middle leg with identical results, and likewise with the left hind leg. The right middle leg, the only one remaining, was then grasped and notwithstanding the vigorous struggling of the trunk, the limb remained attached to the body. From this it would seem that: 1. A mechanism independent of the head controls the reactions and, 2. That the reaction does not occur when only one leg remains, the minimum for any kind of limb locomotion. Similar studies were conducted on undecapitated less mature forms—in the green stage—without like results, that is, in less mature stages the insect could be handled by any of its limbs without their being detached. Like negative results were obtained with undecapitated *Mantis religiosa*.

C. C. GUTHRIE

UNIVERSITY OF PITTSBURGH

SPECIAL CORRESPONDENCE

THE RACES OF MANKIND

IN presenting the Hall of Races of Mankind (Chauncey Keep Memorial Hall) to the public in June, 1933, Field Museum of Natural History, Chicago, has departed boldly from all precedence for anthropological exhibits. The hall contains 87 life-size bronze sculptures (30 full-length figures, heads and busts) representing typical members of the more important divisions of the human race. This gigantic task was accomplished by a great artist and a great humanist, Malvina Hoffman, an American sculptor of international repute. Her work proceeded with the enthusiastic cooperation and under the close supervision of eminent scientists.

In 1915 plans for a new anthropological exhibit were prepared by Dr. Berthold Laufer, curator of anthropology in Field Museum since that time. During the past six years the writer has studied exhibits in the foremost museums of America and Europe, and in this project the cooperation and advice of leading scientists of the world has been generously given. It was felt that a display of skulls, charts, casts and photographs, extensive and accurate as they might be, would nevertheless fail to make a clear and lasting impression on the mind of the varying forms and characters which distinguish one race from another. A new and a more satisfactory solution to the problem was sought—and a great artist was called upon.

Malvina Hoffman, a favorite pupil of the great French sculptor, Rodin, has for twenty years enjoyed a notable reputation for her portrayals of the human face and form; and her sculptures are exhibited in some of the great museums and art galleries on both sides of the Atlantic.

Since her appointment by the museum, Miss Hoffman has spent nearly five years in studying, photographing and modeling typical members of the various human races. In addition to the technical advice rendered by the museum's department of anthropology, Sir Arthur Keith was indeed most generous with his advice and his letters of introduction, which, together with those from Dr. Laufer, opened every door to her. She traveled around the world in search of material, and in each country visited, leading anthropologists offered her every assistance and gave her aid in choosing her models. Field Museum's requirements for scientific accuracy above all else have been most satisfactorily fulfilled.

Miss Hoffman, having employed the precise methods of the anthropologist, has, in addition, achieved something far greater than the accuracy afforded by calipers and camera. She has immortalized in bronze the spirit and character, as well as the bodily form of each of her subjects. Not a single type has been idealized or subjected to racial prejudice; each model is portrayed in a natural pose, with sympathy and appreciation of his individuality. The Hall of Races of Mankind offers a unique and unprecedented opportunity for studying and comparing the many divergent forms and the striking similarities of the various branches of the human family.

The center of the spacious hall is dominated by a symbolic group of heroic size, the Unity of Mankind,

representing the three main branches of the human species—a black, a white and a yellow man. In alcoves around the hall are displayed racial types geographically arranged by continent.

On entering the hall from the west, one meets, on the right hand, natives of Africa. A Bushman of the Kalahari Desert, in characteristic posture, is about to release an arrow from his bow, while his wife squats beside him, her small baby strapped to her back. In contrast to these diminutive people, a tall and lithe young girl of the Sara tribe is poised to begin a dance, incomparable grace in her slender limbs and a vivacious smile upon her face. Near her, a Senegalese drummer beats upon his tom-tom, his head thrown back in a rapt and dreamy expression. A Batwa boy from the Belgian Congo grins mischievously, showing his filed teeth. From East Africa an extremely tall young Shilluk warrior of serious mien stands on one leg in the peculiar stork-like posture characteristic of his tribe. Numerous other figures portray the divergent racial types of the African continent.

On the left-hand side, races of the many islands of Oceania and of Australia are shown. A full-length figure of an Australian mother and son and of an Australian man reveal not only the bodily form, but the undeveloped intellect of that primitive race. A muscular Solomon Islander, of fierce expression, is climbing a cocoanut palm. The Polynesian race is represented by a Hawaiian skimming toward the beach on his surf board, every muscle of his fine body tense with life.

In the central section of the hall, European types are represented on the right hand: among them, a Sicilian fisherman of Mediterranean type; the full-length figure of a Nordic man; a woman from Brittany wearing her quaint bonnet. On the left-hand side are American Indians and Eskimo types from the American continent. A prominent place is given to the full-length figure of a rugged middle-aged Ainu, a member of that ancient and fast-disappearing race now confined to the islands of northern Japan.

The east end of the hall is devoted to the many and varying Asiatic types. The remarkably slender figure of a Vedda from Ceylon is portrayed in the full-length figure of a young man, his long bow in his hand. A Kashmiri sits in the characteristic attitude of meditation. The delicate face of a woman from Jaipur, India, carved in stone, contrasts markedly with the wrinkled countenance of a Rajput woman of the "untouchable" class. Chinese and Mongol types are well represented; and an old Tibetan merchant from Lhasa sits cross-legged on a rug. There is a young Japanese woman with elaborate hair dress, and a fine head of a Japanese man of the upper class.

Only a few of Field Museum's great assemblage of races have been mentioned. Many of the types here represented will probably be extinct within a few decades, but their faces and forms are nowhere as well preserved for posterity as in the Hall of Races of Mankind.

A section at the east end of the hall will be devoted to physical anthropology. The exhibits will include anthropometric instruments with an explanation of the methods employed; growth changes; stature in various races; the use of the hand and foot; hair samples; charts showing variations in eye color; the shape of the nose, the mouth and the ear. The range of variation in skin color will be shown by means of colored transparencies arranged by continent. A section will be devoted to demography, wherein vital statistics, multiple births, growth of populations, racial problems in the United States, immigration questions and longevity in races will be illustrated. There will be an exhibit showing the effects of epidemics and disease on populations. The racial characteristics of the skeleton will be shown, together with a type series of skulls to show racial variations. Skull deformation with appliances and distribution maps showing ancient and modern practises of this custom, as well as examples of trepanning and trephining, will be included. Finally, there will be an exhibit of comparative osteological material showing typical adult male skeletons of man and the anthropoids.

HENRY FIELD

FIELD MUSEUM OF NATURAL HISTORY

REPORTS

THE LONG BEACH EARTHQUAKE[1]

THE first motion recorded at the Seismological Laboratory in Pasadena from the Long Beach earthquake was at 5h. 54m. 19.3s., P. M., on March 10, 1933, with a possible error of one or two tenths of a second; it was also recorded at various times less than 45s. later, at our six other stations in southern California. Thus guided, the origin of the shock was determined to be a point in the ocean about 17 miles to the southeast of Long Beach and 3 miles to the west of Newport at 33° 34½′ north latitude, 117° 59′ west longitude, with an error of probably not larger than 5 km., perhaps not larger than 2 km. Hundreds and hundreds of after-shocks were also recorded; they

[1] Abstract of reports made to the Los Angeles Section of the American Society of Mechanical Engineers on April 12, 1933.

do not all seem to come from the same point of origin, although none come from far away. It is not impossible that, as the shock is believed to have been due to movement on a fault trending northwest, the after-shocks were developed more to the northwest than the main or first shock This, however, is not very probable.

The varying measures of damage may be explained from my experience in the San Francisco earthquake of April, 1906, where I spent 2½ months on the ground studying its effects. The underground structures varied greatly in that district; and it was found that the destructive effects over most of the shaken area varied more with the nature of the underground and with the strength of building construction than with distance from the earthquake center, the destruction being greater on alluvium than on rock. In the Long Beach district the ground conditions vary from graded and filled ground through wet natural alluvium to firm hilly ground.

The fall of buildings and chimneys at Long Beach was predominantly to the north and slightly to the east. The amount of movement there has not yet been determined; but at Pasadena the shock began with small, rapid-motion waves which lasted for 5 or 6 seconds; and these were soon followed by slower waves causing a recorded amplitude of slightly over 3 inches with a period of 8 or 10 seconds.

Earthquakes may be classed both as to their magnitude and as to their intensity. In magnitude the Long Beach earthquake was not a great shock, but a moderately strong, local shock. In intensity it reached VIII (possibly IX) on the Modified Mercalli Scale of 1931, which specifies twelve grades. It was of about the same energy as the Santa Barbara earthquake of 1925. On the other hand, the energy of the San Francisco earthquake of 1906 was more than a thousand times greater than either of these southern shocks, and its shaking continued longer. Had the buildings in San Francisco been of the same defective quality as those at Long Beach, the damage there in 1906 would have been much greater than it was.

Earthquake prediction is at present impossible, but from the experience of southern California for the past century, it appears that the earth's crust here is in a serious state of strain and that we may expect such moderate shocks as we have lately had until a stronger shock brings relief to the whole area.

H. O. WOOD

SEISMOLOGICAL LABORATORY
CARNEGIE INSTITUTION OF WASHINGTON
PASADENA

WHAT HAPPENED GEOLOGICALLY

California lies in a zone of active mountain-making; and our earthquakes are merely the growing pains of our mountains. Our scenic topography is largely the direct result of geologically recent displacements on faults, many of which are still active and of so recent a date that erosion has not yet effaced their scarps. The movement on the fault which caused the Long Beach earthquake took place under the ocean about 3 miles off shore, and hence the fault can not be examined directly; but it is traceable in its extension northwestward through the Los Angeles district, where it is known as the Inglewood fault, which was active in that suburb in the earthquake of 1920. Its length is moderate; much less than that of the great San Andreas fault, movement on which caused the San Francisco shock of 1906 and which has been traced from hundreds of miles north of the Golden Gate far southward nearly to and perhaps into Mexico.

The fault system of southern California includes six or seven main fractures, trending northwest-southeast. Nearest the coast is the Inglewood fault, above mentioned; next inland comes the Elsinore or Whittier fault, which starts in the Gulf of California, comes up through the Peninsular mountains, and appears to die out east of Los Angeles. Third is the San Jacinto fault, which also comes from the Gulf of California, runs through San Jacinto and the Cajon Pass, beyond which it joins the above-mentioned San Andreas fault, the fifth and greatest member of the system. These faults divide southern California into a series of great slices or blocks, a few miles wide and a few tens or a few hundreds of miles long. Their geological structure shows that they have acted rather independently. They have been in movement for millions of years. It is little slips in their movement which cause our earthquakes.

It appears that the adjoining part of the Pacific basin is slowly moving northwestward with respect to the continent and that the movement is distributed on our fault system. Of two adjoining fault slices, the southwestern one always, as far as our experience goes, moves northwestward with respect to the northeastern one. The slices are believed to be moving at a very slow but constant rate. Where they are in contact they tend to stick together and a condition of strain is there built up by friction of slice on slice. When the movement of the slices has gone far enough, friction is overcome by the strain and a slip occurs, not because of any sudden movement in the entire slice, but only for the relief of the strained margins of the two slices. The Long Beach earthquake is believed to have been caused in this way, even though the part of the fault on which its slip occurred is below the sea. The slip is measured in feet or tens of feet in strong earthquakes; it may last for a fraction of a minute in small earthquakes, it may continue one or two minutes in great earthquakes. To

build up marginal strain sufficient to produce a slip and thus cause an earthquake may require slice movement during a decade or a century, but not until man has lived in California one or two thousand years can accurate judgments be made of that matter.

When a slip takes place, the adjoining fault surfaces move with a grating effect because they are not smooth. Waves of several kinds and of unlike velocities, thus set up, are propagated through the earth; and when they reach the surface, an earthquake is there experienced. Its destructive effect is greater if it emerges through alluvium than through solid rock. Just as a shock causes jelly in a dish to quiver more than the dish, so alluvium quivers more than the bed rock on which it lies. For that reason the damage in the recent earthquake was greater at Long Beach and Compton, which are built on an alluvial plain on the coast twenty miles north of the earthquake origin, than at Laguna, which is built on a rocky coast only twelve miles southeast of the origin.

We must recognize that southern California will continue to have earthquakes, not periodically, not regularly, but at unknown intervals; and we should therefore build for safety against them. We must demand earthquake-resistant construction for safety of life and property.

J. P. BUWALDA

DEPARTMENT OF GEOLOGY
CALIFORNIA INSTITUTE OF TECHNOLOGY

ENGINEERING LESSONS OF THE QUAKE

Civil engineering has been defined as the science of building things that stand up and mechanical engineering as the science of building things that move. During an earthquake things move, but they are also expected to stand up. This may be the reason for having a civil engineer speak at a meeting under the auspices of mechanical engineers. The destruction by an earthquake is the result of inertia, not only of buildings and other structures, but to perhaps a greater degree of human inertia. Engineers can deal tolerably well with the inertia of inanimate things, but feel much more helpless in overcoming the inertia of human nature.

The vertical component of an earthquake motion is generally of less amplitude than the horizontal, and it is customarily disregarded in discussions of engineering design because the factor of safety provided for static vertical force is ample to take care of added stresses produced by the vertical component of earthquake motion. There is quite general agreement that earthquake damage to buildings is due principally to horizontal forces. Building regulations in Japan, Italy and New Zealand, representing the consensus of opinion of engineers who have considered the problem, require that designs shall provide for an arbitrary horizontal acceleration of the order of 1/10 gravity. This is the most reasonable and expedient method at present available to minimize earthquake hazard to life and damage to property. The approximate additional cost of incorporating this resistance to horizontal forces in a building of Class "A" is from 5 to 7 per cent. of its total cost. This should not be misinterpreted to mean that a Class "C" building can be converted to an earthquake-resistant Class "A" structure for an additional cost of 5 to 7 per cent.

The earthquake of March 10 was discriminating. The buildings that it singled out for destruction were the worst of design, material and workmanship. It emphasized, what every one now accepts, that the function of mortar is to hold bricks together, not to keep them apart. The desirability of using cement mortar and wet brick is not a new discovery. It was advised after the San Francisco fire of 1906 and after every subsequent earthquake. But why repeat what has been said so often. Existing publicly owned buildings, such as schools, can be remodeled to reduce the menace to the lives of the children. Each building should be studied by a structural engineer as thoroughly as he would a limit-height office building. Even though the existing schoolhouses can not be made as earthquake resistant as new structures specially designed with this end in view, the danger to life can be reduced greatly.

With privately owned, Class "C" buildings, such as stores, the problem of finance is greater than that of design. Building codes can not be made retroactive. Whatever method of bringing about the betterment of these buildings is used, the job is not exclusively for the engineer. Perhaps the biggest contribution he can make is to keep the interest in earthquake-resistant construction from waning, as it has too consistently after all past earthquakes; then we may hope to have buildings so safe that we may adopt as a slogan: "Come to California and enjoy the earthquakes."

R. R. MARTEL

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SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD OF MOUNTING MAPS

MOUNTED maps are more durable and do away with the possibility of being torn during classroom or field use. In universities there often arises the need for mounted maps and the facilities for mounting are lacking. At Syracuse, in the geology and geography

department, the necessity of having maps mounted with small expenditure resulted in the development of the following technique.

The method of map mounting described here is mainly the result of the writer's personal experience, suggestions offered by Mr. Hawthorne Daniel, of the American Museum of Natural History, and general references.[1]

The size of the mounting surface should be determined by the unit size of the map or number of maps to be mounted. The one used by the writer is sixty-six inches wide, one hundred and forty-four inches long and two inches thick. This width takes the full two-yard-wide bleached sheeting and the length accommodates a large number of small maps at one mounting. The thickness is such that it prevents warping from wetting.

The first essential of good mounting is a smooth, flat, fine-grained surface, on which the cloth may be securely stretched. The writer has found that a mounting board of white pine with a sanded surface is very satisfactory. The board is backed by three oak battens (2″ x 4″) which also prevent it from warping. Nails (2″ finishing nails) are toenailed every six inches along the sides with the points slightly projecting underneath, on which the cloth is caught as stretched.

Second, bleached muslin is necessary for permanent and high-grade mounting because of the increased adhesive qualities over unbleached cloth. All the maps at Syracuse are mounted on either Ranger or Pequoit quality sheeting at an approximate cost of twenty-five cents per yard in fifty-yard bolts seventy-two inches wide.

Third, a good quality of flour paste is essential. The boiled paste is better than cold-water paste. Steko Paste, made by the Steko Paste Company, of Rochester, N. Y., has been used and found satisfactory. This comes as a dry flour in two-pound bags.

Fourth, as the paper of the maps varies greatly, only experience will determine the proper dampness to mount maps. Matching of two parts of one map or of two maps is done before dampening to check the match and to insure soaking according to the amount of stretching necessary to match the smallest of the sheets. Both sides of the map sheet are sponged off so that the paper is soft but not coated with a film of water and so that all the wrinkles have been removed.

[1] "Notes on the Cataloging, Care and Classification of Maps and Atlases," by Philip Lee Philips, F.R.G.S., Library of Congress, Government Printing Office, 1921. "Directions for Mounting Maps," U. S. Geological Survey.

Fifth, large rubber window squeegees (12″ and 16″) are used, one for spreading the paste and one for smoothing the map and wiping off the excess paste. The greater the pressure applied the more closely will the map adhere to the cloth. All air bubbles must be removed, that the maps may lie perfectly flat with no wrinkles. There is little need to try to keep paste off the surface of the map, in fact, a little aids in working the softened paper. The excess need only be squeegeed off. After drying the slight coating of paste will be unnoticed.

Maps must be completely dry before being removed from the board in order that they may remain permanently flat. To insure proper drying, the room in which the maps are mounted should be a fairly dry one and remain so at all times of the year.

The finishing of the maps is determined by their ultimate use. Maps mounted for desk or field work are trimmed or folded. Maps for wall use require trimming and then half-round molding (usually one half inch) is used. Two pieces to form a full round with small §″ No. 4 flat head wood screws holding them together aid in handling and hanging the larger maps. These rounds are sometimes fastened with glue in addition to the screws. Best effects are produced by staining the molding. Screw eyes, with wire for hanging and other finishing touches, may be added to suit the needs of the users.

VINCENT M. THROOP

SYRACUSE UNIVERSITY

A CONVENIENT COLOR CHART FOR GENETICISTS

FOR the past year I have been using a color chart which has proven to be well adapted for genetic work. It does not give a precise and permanent record of every shade of color, as do Ridgway and other charts of that nature. It is, however, cheap and convenient and is roughly quantitative. The chart measures 12 inches in diameter and is approximately circular. There are eighteen colors arranged radially like the spokes of the wheel, blue, violet-blue, blue-violet, violet, red-violet, violet-red, red, etc., through oranges, yellows and green back to the blues again. Each color is divided into seven shades, grading from black at the center to a pale tint at the periphery. It is a matter of only a moment when scoring a plant, to move the petal back and forth until an approximate match is reached. The chart is not well adapted to scoring the peculiar colors met with in certain Nicotiana hybrids, where varying shades of yellow and green are overlaid by pinks, reds and violets. I have, however, used it successfully on Tradescantias, Aquilegias and Irises. While it would probably fade, if

constantly exposed to strong light, my copy, which I have mounted on strong cardboard and keep folded when not in use, has not changed perceptibly in nearly a year. The chart is known as the "Fischer Color Chart" and may be obtained from the Secretary of the New England Gladiolus Society, Mr. C. W. Brown, 13 Park Road, Ashland, Massachusetts.

EDGAR ANDERSON

ARNOLD ARBORETUM
HARVARD UNIVERSITY

SPECIAL ARTICLES

A GROUP OF CHEMICALS ACTIVE IN INCREASING TISSUE PERMEABILITY AND ENHANCING CERTAIN INFECTIOUS PROCESSES

ATTEMPTS have been made to isolate and identify the factor demonstrated in testicle and certain other normal tissues, which has the property of increasing tissue permeability and enhancing the lesions resulting from infectious agents. Recently it has been shown (Goodner, Duran-Reynals) that certain invasive micro-organisms possess an extractable substance with similar properties.

In the course of this study, many chemicals and various tissue components as widely related as histamine, tyrosine or nucleic acid have been repeatedly tested in different ways with the hope of tracing the specific properties to some known physiological agents. However, the substances so far investigated have failed to show any power in increasing tissue permeability or augmenting infectious lesions.[1]

When working on the fractionation of testicle extract and the isolation of the soluble factor from staphylococcus, it was found that the activity in solutions would always correspond to a strong diazo reaction, while inactive fractions discarded during the purification would regularly give negative chemical tests. This observation indirectly led to the trial of pure diazo-compounds on dermal permeability. These proved to possess the property of reproducing the effect so far obtained only with extracts from certain tissues and virulent bacteria. The present paper deals with the activity of the diazide of sulfanilic acid under various conditions.

The p-sulfanilic acid itself from which the reagent is prepared is entirely inert, and the response is never different from that of the control. On the other hand, when a certain quantity of the diazonium derivative, namely p-diazo-benzol-sulfonic acid, is dissolved in water by means of sodium hydroxide and intradermal injections are made with India ink as indicator, this is followed by sudden and complete diffusion of the material injected. However, contrasting with the speed with which diffusion takes place, one observes a limitation as regards the area involved, and the surface of diffusion can not be appreciably increased even by the use of much more concentrated solutions.

The explanation of this fact was that we were dealing with a substance rather soluble in water which would first spread rapidly through the tissue spaces but would soon be taken up by the larger lymphatic vessels and carried away into the circulation. Consequently, it was thought that more favorable conditions for the production of the phenomenon could be obtained if the active reagent were linked to a larger molecule. Coupling of the diazide with gelatin, casein, egg albumin and horse serum was attempted. The preparations obtained from gelatin and casein were not very satisfactory. On the other hand, the diazo compound reacts readily with egg albumin and serum. These proteins can absorb large amounts of the reagent if adequate alkaline reaction is provided, and they yielded very active preparations.

The intradermal injection in rabbits of 0.5 cc of such azo-proteins with 0.25 cc of India ink suspension as indicator results in a gradual spreading of the material and the diffusion may continue to progress during several hours. The ink particles are almost completely carried away from the site of inoculation and in certain instances preparations can be made so that the diffusion area easily covers more than 120 sq. cm of the skin. The ink diluted with Ringer's solution and injected intradermally in the same amount remains for some time in a distinct bleb and its eventual diffusion is limited to a small area immediately around the site of injection and rarely greater than 4 sq. cm.

Moreover, the diazo-compound so combined with albumin or serum also possesses the property of enhancing infectious processes. Tested with progressive dilutions of vaccine virus it not only has the power markedly to increase the size of the local lesions (45 sq. cm as against 6.0 sq. cm for the control in a typical experiment), but exhibits a definite enhancing effect. In the higher dilutions, while the control injections remained completely negative, the same material with the azo-protein was able to develop typical and well-defined lesions.

[1] McClean has reported that certain protamines possessed the property of increasing dermal permeability, but inhibited infectious agents through their antiseptic power. However, these protamines were extracted from fish sperm and, in a recent private communication, McClean stated that by means of fractionations carried out with Morgan, he was able to refer their action on tissue permeability to the testicle factor itself contaminating the sperm proteins.

Experiments in view of determining which group in the molecule is actually responsible for this specific activity are under way, and other diazo- and azo-compounds are being tested in this respect.

The study has not progressed to a point where it is possible to discuss the chemical relationship between the synthetic spreading factor and the biological one obtained from certain tissues and from invasive bacteria. As far as can be judged, their activity in increasing tissue permeability and enhancing infections is identical, and no other chemicals have been found which bring about these results. Recently a crystalline product has been obtained from testicle extract and from *Staphylococcus aureus* extract. In the latter this product is comparatively easily isolated, and even after five consecutive recrystallizations it retained the typical spreading and enhancing properties. The chemical constitution of this material is being investigated.

ALBERT CLAUDE

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A PHYTOPHTHORA DISEASE OF SNAPDRAGONS

DURING March, 1932, a wilt disease of snapdragons appeared in several greenhouses near San Leandro, California. Approximately 50 per cent. of the plants were either killed or so badly injured that they were of no commercial value. As a result of the damage done by this disease several thousand dollars' worth of flowers were destroyed. The grower was not familiar with the trouble and had no conception of what was doing the damage. He thought it might be due to improper soil or water conditions. The disease was found in all parts of the affected houses. Plants were observed in all stages of infection ranging from those on which a few stem branches were wilted to those which were browned and drying up. A careful examination showed that the outer tissues at the bases of the stems and on the larger roots were decayed. On a good many of the plants the cortical tissue was so badly decayed that it had become separated from the plant, resulting in the wilted condition. On some of the plants only a very narrow band of living tissue on one side of the stem was keeping the plant alive. The lesions were found at the ground line or beneath it. They ranged in color from a very light yellow to a deep brown. Affected tissue appeared at first to be water-soaked. As the disease progressed the lesions became sunken, followed by sloughing off of the outer tissues, thus eliminating all the growing part of the plant stem. On a few of the plants the fungus was observed attacking branches several inches above the surface of the soil, but this occurred only when the plant stems were very wet.

Isolations were made from tissues and three organisms were found; a bacterium which produced a yellow culture, a fungus *Cephalosporium acremonium* Corda, and a Phytophthora which has been tentatively identified as *Phytophthora cactorum* (Leb. and Cohn) Schrt. These three organisms were repeatedly isolated from diseased tissue both separately and together in mixed cultures. A pure culture of each organism was used to inoculate plants under greenhouse conditions. Snapdragon plants were grown from seed in sterilized soil until they were near the blooming stage. They were inoculated with cultures of the fungi which were grown on corn-meal and sand and with a spore suspension of the bacterium. Inoculations were so made that each organism was placed on plants alone and in combination with the other two. As a result of these inoculations it was found that only the Phytophthora was pathogenic on the snapdragon plants. Neither the Cephalosporium fungus nor the bacterium gave any indication of being pathogenic. All the plants exposed to the Phytophthora fungus wilted down within two weeks of exposure and showed symptoms identical with those noted in the greenhouse at San Leandro. The Phytophthora fungus was reisolated from all the inoculated plants which became diseased. Tissues from the diseased plants were fixed, sectioned and stained. A study of these slides shows that the fungus belongs to the *Phytophthora cactorum* group of Phytophthora. Studies are now in progress covering the growth of the fungus on various kinds of media. An effort was made to trace the source of the infestation in the greenhouse. It was found that one of the sources of the water in the greenhouse was contaminated and also the compost soil used by the grower was infested. The disease was entirely eliminated during the past winter season by using clean water and sterilizing all soil from the compost pile. Work on this problem is continuing and a more complete account of the study will be given in a later paper.

M. R. HARRIS

CALIFORNIA STATE DEPARTMENT
OF AGRICULTURE
SACRAMENTO

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